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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Application of : **ZELIG et al.**

Serial No.: 09/978,342 : Group Art Unit: 2667

Filed : October 17, 2001 : Examiner: Rhonda L. Murphy

For : SONET CIRCUIT EMULATION WITH VT COMPRESSION

Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

DECLARATION UNDER 37 CFR 1.131

Sir:

We, the undersigned, David Zelig, Leon Bruckman, and Nitzan Kappel, hereby declare as follows:

1) We are the Applicants in the patent application identified above, and are the inventors of the subject matter described and claimed in claims 1-60 therein.

2) Prior to May 7, 2001, we conceived our invention, as described and claimed in the subject application, in Israel, a WTO country. Conception of the invention is evidenced by a disclosure written by David Zelig, entitled "Proposed patent on VT compression of Circuit Emulation Packets," which is attached hereto as Appendix A.

3) On May 7, 2001, David Zelig sent the disclosure as an attachment to an e-mail message to Leon Bruckman. The e-mail message and the attached disclosure were saved on the internal mail server at Corrigent Systems (assignee of this application). A copy of the e-mail message is attached hereto as Appendix B.

4) The following table shows the correspondence between the elements of claim 1 in the present patent application and statements in the Disclosure attached as Appendix A:

Claim 1	**Disclosure**
A method for data communications, comprising: receiving a time-division-multiplexed (TDM) input signal on a first circuit, the signal comprising an input sequence of frames of data, each such frame divided into sections for carrying respective sub-rate payloads	These features (TDM signals and division of frames into sub-rate payloads) are inherent in SONET data transmission. Division of STS-1 frames into tributaries at lower rates is described in the last paragraph on page 2 of the Disclosure.

Claim 1	**Disclosure**
determining which of the sections are active, such that the data in the sub-rate payloads of the active sections comprise user data, and which of the sections are inactive	"The 'packet engine' block will be configured which VT are equipped…," i.e., active. "… the unused columns are not transmitted" (page 3, "VT compression Method").
encapsulating the user data in the active sections into data packets for transmission over a packet network, while omitting from the packets at least some of the data from the inactive sections	"Before transmitting the packets…, the unused columns are not transmitted. For example, if VT1.5 #1,1 and 2,1 are active, only columns #1 (path overhead), #2,31,60 (1,1) and 3,32,61 (2,1) are sent" (page 3, "VT compression Method").

The above table demonstrates that we conceived the entire invention, as recited in claim 1, prior to May 7, 2001. Based on the similarity of subject matter between claims 1 and 31, it can similarly be demonstrated that we also conceived the entire invention recited in independent claim 31.

5) The following table shows the correspondence between the elements of independent claim 23 in the present patent application and statements in the Disclosure attached as Appendix A:

Claim 23	**Disclosure**
A method for applying a circuit emulation service (CES) to a Synchronous Optical Network (SONET) input signal that includes a plurality of input virtual tributaries containing data	Application of CES to SONET is explained in the "Background" section on page 1. Division of STS-1 frames into virtual tributaries is described in the last paragraph on page 2.
determining which of the input virtual tributaries in the SONET input signal are active, such that the data in the active virtual tributaries comprise user data	"The 'packet engine' block will be configured which VT are equipped…," i.e., active (page 3, "VT compression Method").
receiving the SONET input signal at a CES transmitter on a first SONET link	Figure 3 on page 3 shows a CES line card. "… CE1 accept the [SONET] OC-N signal…" (page 3, "VT compression Method").

Claim 23	**Disclosure**
encapsulating the user data in the active virtual tributaries of the SONET input signal into data packets at the CES transmitter, while omitting from the packets at least some of the data from the inactive virtual tributaries	"CE1 takes the path signal and create equal length packets…" (page 2, second paragraph). "… the unused columns are not transmitted. For example, if VT1.5 #1,1 and 2,1 are active, only columns #1 (path overhead), #2,31,60 (1,1) and 3,32,61 (2,1) are sent" (page 3, "VT compression Method").
transmitting the packets over a packet network from the CES transmitter to a CES receiver	"… CE1… send the packets for CE2 for transmitting it on the outgoing interface" (page 3, "VT compression Method"). "CE1… deliver the packet to CE2" (page 2, second paragraph).
extracting the user data from the packets at the CES receiver	"At CE2, the received packets are inserted into a buffer… to synchronize the transmition to the outgoing OC-N signal" (page 2, fourth paragraph).

Claim 23	**Disclosure**
generating a SONET output signal comprising output virtual tributaries at the CES receiver by inserting the extracted user data from each of the active virtual tributaries into a corresponding one of the output virtual tributaries	"At the receiving end, the packet is treated based on the same procedure in [MPLS-CES]… There is an option that the RX side will place the accepted VT1.5 in different columns…" (page 3, last paragraph - page 4, first paragraph).

The above table demonstrates that we conceived the entire invention, as recited in claim 23, prior to May 7, 2001. Based on the similarity of subject matter between claims 23 and 53, it can similarly be demonstrated that we conceived the entire invention recited in independent claim 53.

6) On May 10, 2001, we sent the above-mentioned Disclosure, along with other materials, to Dr. Daniel Kligler, of Sanford T. Colb & Co., who was retained by Corrigent Systems for the purpose of preparing the present patent application. We asked Dr. Kligler to prepare a U.S. provisional patent application using these materials.

7) On July 9, 2001, Dr. Kligler's office completed and sent the provisional patent application for filing in the USPTO. It was filed on July 10, 2001, and received

serial number 60/304,369.

8) On July 16, 2001, we met with Dr. Kligler to discuss preparation of a regular patent application claiming the benefit of the above-mentioned provisional patent application.

9) On August 9, 2001, we received a first draft of the regular patent application from Dr. Kligler. Between August 9 and August 30, the application underwent several revisions. We approved the final draft on August 30, 2001.

10) After we executed the filing documents, the regular patent application was then sent to the United States, where it was filed in the USPTO on October 17, 2001. It received serial number 09/978,342.

We hereby declare that all statements made herein of our knowledge are true and that all statements made on information and conjecture are thought to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application of any patent issued thereon.

US 09/978,342

Declaration under 37 C.F.R 1.131 by Zelig, Bruckman and Kappel

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APPENDIX A

Proposed patent on VT compression of Circuit Emulation Packets

Remark: in the following SONET terminology is used, but the same apply for SDH.
SONET <-> SDH
STS-Mc <-> STM-Mc
SECTION <-> Regenerator Section Overhead (RSO)
LINE <-> Multiplexing Section Overhead (MSO)

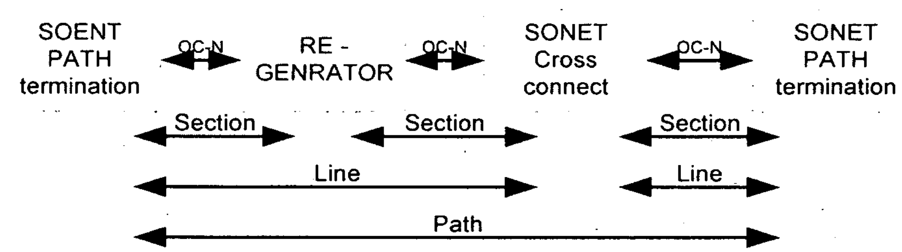
Background

Circuit Emulation Services (CES) is a promising technology for transporting of legacy PDH and SONET signals over packet networks. The technology enable to maintain one packet network from operations point of view, while keeping existing services interfaces at the edge of the networks in their original format. An example may be connecting DS1 interfaces as a point to point service, while the DS1 signal is carried on packets inside the core network. The service to the end user is transparent DS1.
CES services may be based on many technologies, depending on emulated signal and the underlying packet network technology. One of the technologies is to carry SONET signals over packet network, typically MPLS network but not limited too. A reference for this topology is in [MPLS-CES], which is a private case of layer 2 emulation over MPLS as described in [MPLS-L2].

SONET is divided into at least three hierarchies (see [GR-253] and the figure below):

Section: Control plane between regenerators or between directly attached SONET NEs.
Line: Control plane between two SONET NEs, the line control plain is transparent for regenerators.
Path: Control plain between the two path end points, which transverse many SONET NEs.

Figure 1



SONET layering

The path signal may contain either directly mapped data or additional encapsulations of lower rates signals such as DS3, DS1, DS2 etc.

In MPLS SONET CES, it is assumed that the emulation is done at the path level. It enables to connect to the packet network different OC-N signals, and making path level cross connect between the ports that are physically remote from each other. For example, each STS-1 in one OC-3 port can be sent and received from a different OC-N port on another node. The Figure below describes the function of the virtual digital cross-connect.

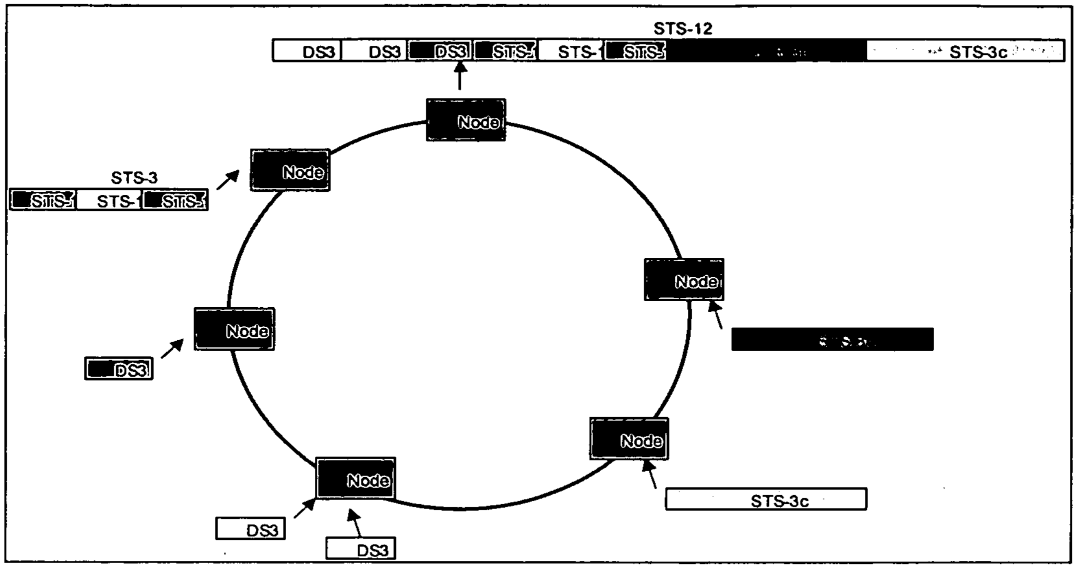


Figure 2 – Virtual cross connect network

Notes: 1) In traditional SONET network, path cross connect may be done only between interfaces on the same physical equipment.
2) DS3 over STS-M is not exactly as shown (each DS-3 is first mapped to STS-1).

How SONET CES works (see more details and block diagrams below, and in {MPLS-CES]).
Assume two circuit emulation nodes CE1 and CE2, connected respectively to NE1 and NE2. The emulation needs to carry a path signal that is originate in NE1 and terminate in NE2 (only one direction is described, the other direction is the same)
CE1 terminate the OC-N signal between CE1 and NE1. It terminates the line and section SONET overhead, and extract the path signal. CE1 takes the path signal and create equal length packets, add a CE overhead for each packet, and add (in MPLS case) an MPLS header that are used in the packet networks to deliver the packet to CE2. Each path frame is typically received once per 125uSec, and is floating inside the OC-N signal via SONET pointers mechanism. The packet length is constant, and may include any number of bytes from the path signal (typically integer part of path frame). If pointer adjustments are detected in CE1, they are delivered on the CE overhead and "played" on CE2 outgoing interface.

The CE overhead function is described in [MPLS-CES]. An important part of it is the structure pointer, that point to the path overhead place inside the packet, if exist.

At CE2, the received path packets are inserted into a buffer. The buffer purpose is to absorb any delay variation caused in the packet network between CE1 and CE2. The seq # is used to overcome miss-ordering in the network. The path structure pointer is used to synchronize the transmition to the outgoing OC-N signal. In case of pointer adjustments in CE1, they are played out in CE2 in order to prevent buffer overflow/underflow in case of mismatch between the path rate and the OC-N rate.

Problem to be solved

In many circuit emulation scenarios, the STS-1 are not fully populated. An example is an STS-1 carrying VT1.5 signals (i.e. DS1 encapsulation). If the STS-1 is not fully populated, it is a waste of BW resources on the packet network to carry the full payload of the STS-1.

The structure of STS-1 carrying internal tributaries is defined in [GR-253] section 3.2.4. Each STS-1 may carry up to 28 VT1.5 tributaries; each is carried in 3 columns of 9 bytes each. 2 bytes are used for overheads in each STS-1 frame (125uSec) – See [GR-253] figures 3-9, 3-20 and 3-21.

In [MPLS-CES], it is specified that the whole STS-Mc payload will be sent, and for STS-1, it is specified that each packet will carry 261 bytes worth of path information (i.e. each 3 packets are one 763 bytes path frame). In case of MPLS, this result a required BW of:

(263 path data + 4 CEM overhead + 4 VC header + 4 MPLS header)bytes * 8 bit/byte * 3 frames/125usec / 125uSec = 52.8 Mbps

If for example only 4 VT1.5 are used, we can reduce the rate (see later for additional reduction option) to (assuming sending one packet/frame):

(3 columns * 9 bytes * 4 + 9 bytes path overhead + + 4 CEM overhead + 4 VC header + 4 MPLS header) bytes * 8 bit/byte / 125uSec = 8.256 Mbps.

The same issue is true for both VT1.5, VT2, and VT6 in SONET, and the equivalent TU-11, TU-12 and TU-2 in SDH systems. We will use the term VT from now on for description simplicity. Explicit examples will be shown for VT1.5, with trivial adaptation to the other rates.

Typical circuit emulation line card

A typical implementation of the CES line card is shown below:

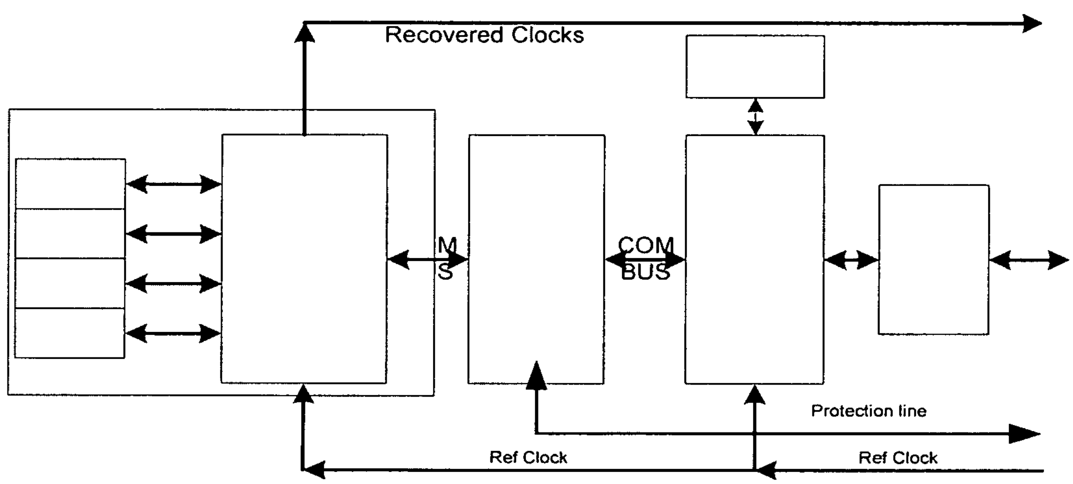


Figure 3 Example of Circuit emulation edge system

VT compression Method

Assume to edge CE devices, CE1 and CE2, where CE1 accept the OC-N signal, divide it to STS-Mc level and for some or all STS-1 need to apply compression and send the packets for CE2 for transmitting it on the outgoing interface.
The procedure described above and in [MPLS-CES] is used to construct the data packets with the following exceptions:
The “packet engine” block will be configured which VT are equipped and shall be carried over the service. Before transmitting the packets (or at packet generation internally), the unused columns are not transmitted. For example, if VT1.5 # 1,1 and 2,1 are active, only columns #1 (path overhead), #2,31,60 (1,1) and 3,32,61 (2,1) are sent. See [GR-253] figure 3-11 for details.
At the receiving end, the packet is treated based on the same procedure in [MPLS-CES], except from the fact that missing columns are added with the default values of empty VTs.

There is an option that the RX side will place the accepted VT1.5 in different columns (i.e. the columns will be changed between the CE1 input and CE2 outputs). This is effectively VT1.5 cross-connect operation.

In scarcely populated environment, the sent packets may be very short. In this case, the packet should be padded to the minimum packet size of packet networks. The padding is added by the CE1 and ignored at CE2. A trivial implementation of this is to configure CE1 to send non-occupied VT1.5 columns up to the minimum required packet length.

Additional option for the scarcely populated environment problem, is that CE1 will append together two or more original packets, without the VC label but with the CEM header. This will keep implementation simple and as close as possible to the original implementation.

The # of appended packets in this case should be configured on both sides or signaled in advance to service creation.

Timing recovery

The following diagram illustrate the timing recovery for the case that compression is done, but at CE2 (Node B in this case), the transmitted STS-1 has the same frequency of the original STS-1 received in CE1 (Node A). The assumption is that the OC-N signal of both ends is synchronized to the same network clock - the PRS (Primary Reference Clock).

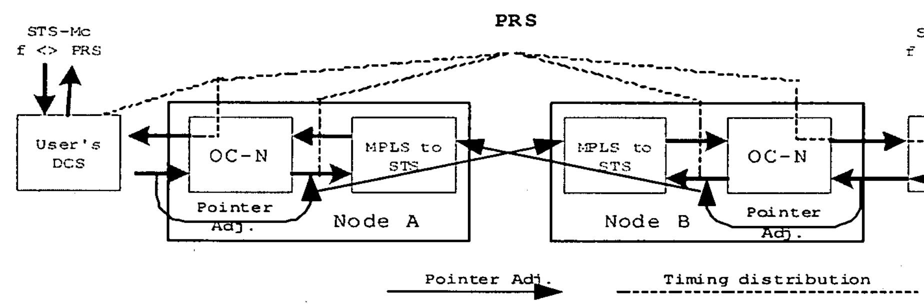


Figure 4 Timing diagram of circuit emulation service

The procedure for timing delivery is the same as defined in [MPLS-CES]. At node CE1, each pointer adjustments (phase deviation between the OC-N and the STS-1 carrying the VT) is carried by the circuit emulation packet. This pointer movement is "played" at the TX side of node CE2.

The next figure show the timing diagram for a different topology, where CE2 path signal is locally generated. This case is relevant when CE2 may get VT1.5 payloads from many sources for the same STS-1. It is impossible to time the STS-1 as before because the original STS-1's may have different timing and significant phase difference may exist between them. The following procedure is used in this case.

Option 1: Destination (CE2) adjustments:
CE2 time the output STS-1 timing from a clock locked to the PRS. CE1 signal pointer adjustments to CE2 with the same procedure as before, but CE2 now adapt the incoming VT1.5 timing to the received pointer adjustments by doing pointer adjustments on the VT1.5 payload. For example: If positive adjustments was signaled, the source was H1,H2 increment at the path level. This will translate to a VT pointer increment at V1, V2 at the tributary level at CE2.

Option 2: Source (CE1) adjustments:

CE1 has the PRS, therefore the VT level adjustments is done at CE1. The sent packet will not carry path level pointer adjustments in this case. CE2 can multiplex the VT1.5 directly into the STS-1 without any.

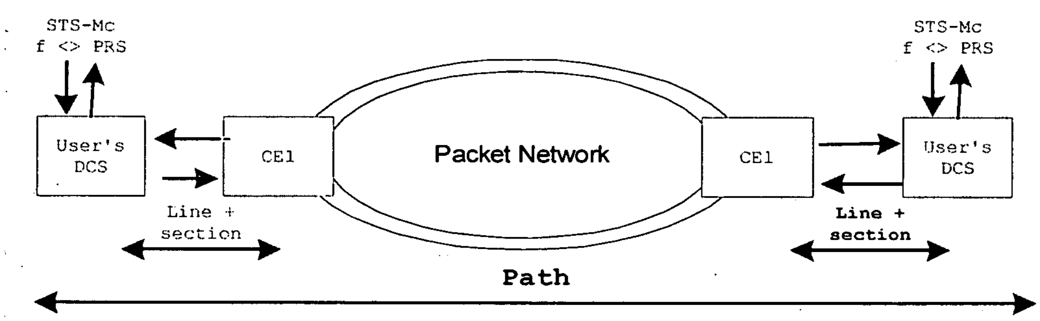
Option 2 is more complex in terms of implementation in CE1, but less complex at CE2. Note that CE2 that enable option 1 is always ready to get signals from sources that are working either based on method 2 or method 1.

Because SONET signals are always bi-directional, it is required that CE2 that accept many sources to the same STS-1 always generate tunnels to the (same sources) from the (same) received STS-1. Typically this circuits are easiest to implement by option 2, but not limited to.

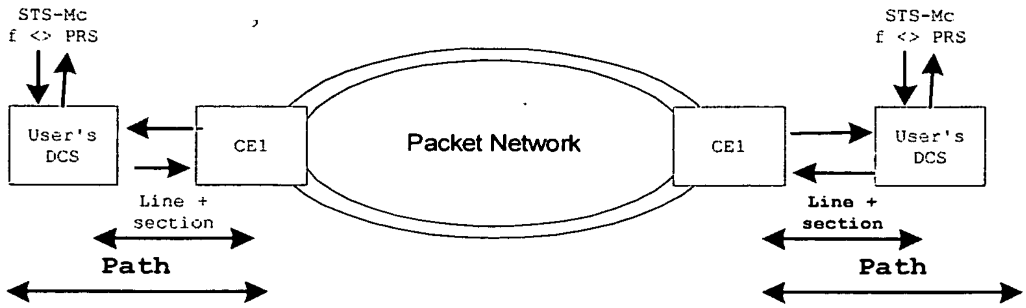
PATH overhead and termination point.

The following describes some issues related to the path overhead transparency over the suggested method.
In general the treatment of path overhead depends on the selection of the operation method in both cases.

Method 1:
In this case the path overhead is generally passed transparently as described in [MPLS-CES]. The compression does not affect the transparent overhead as long that CE2 adds the default values for the unequipped columns as defined in [GR-253]. From SONET point of view, the following describes the reference model:



Method 2:
In this case the path trail must be terminated at the CE1. CE2 is the path source in terms of SONET. The following diagram describe the reference model from SONET point of view:



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[SPECTRA] "SPECTRA 4x155, PM5316 data sheet version 4 "

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Leon,
Please check and remark about the patent.

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APPENDIX B